REMARKS

Claims 71-73 stand rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential elements. Claim 71 has been amended to remove the limitations directed to the temperature.

Claims 50, 67-70, and 74-81 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Emmett, Jr. (US 5,007,620) in view of Brierley (US 5,332,559), McWhirter et al. (US 6,299,776), Eppstein (US 4,680,267) and Vahldieck (US 3,926,794). As previously stated by the Applicant, the present invention is directed to the unexpected discovery of oxygen concentrations in excess of 85% oxygen by volume for C* and oxygen concentrations in the range of 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3 for C_L and using these value parameters in a method of bio-leaching at temperatures that exceed 45°C (see page 10 of Applicant's response to the Office Action mailed on 13 September 2005, lines 12-15). The Applicant repeats the shortcomings of Emmett, McWhirter and Eppstein, referring the examiner to the previous Response for further argument, in that: 1) Emmett is limited to temperatures below 46 °C; 2) McWhirter makes no mention of the unique difficulties associated with making oxygen available to micro-organisms in a slurry when the temperatures exceed 45 °C nor the inhibitory effect high oxygen concentrations may have on the thermophilic micro-organisms; and 3) Eppstein is limited to a means of controlling the dissolved oxygen concentrations in a bioreactor. The Examiner recognizes the shortcomings in Emmett but relies on McWhirter and Eppstein to provide the missing subject matter. However, Applicant's submit that the Examiner has not

provided a motivation for combining the cited references. Even though the prior art reference may be in the same "field of applicant's endeavour...the test of whether it would have been obvious to select specific teachings and combine them as did the applicant must still be met by identification of some suggestion, teaching or motivation in the prior art". In re Dance, 160 F.3d 1339, 48 USPQ2d 1635 (Fed. Cir. 1998). Applicant submits that the Examiner is merely selecting elements from a variety of prior art references directed to bioreactors to obtain the Applicants' claimed invention. The Examiner has not shown a teaching or suggestion in the prior art to support the combination.

The Brierley reference teaches a method for the recovery of a metal value from sulphidic ore. The method includes constructing a heap, in which bio-oxidation takes place, from particulates formed from an agglomeration of sulphidic ore material, using an agglomeration aid, and inoculating the particulates with sulphur oxidizing bacteria (see Abstract). The bacteria used to inoculate the particulates may include facultative and obligate thermophiles such as *Sulfobacillus*, *Acidianus* ans *Sulfolobus* which grow at temperatures in excess of 50°C (page 22, lines 1-5). However, the Brierley reference does not teach or suggest supplying a feed gas containing in excess of 85% oxygen and controlling a dissolved oxygen concentration within a predetermined concentration range. Applicant again submits that the Examiner is merely selecting elements from a variety of prior art references directed to bioreactors to obtain the Applicants' claimed invention without showing a motivation to combine the references.

The Vahldieck reference teaches a method of digesting an organic sludge with the aid of microorganisms. Vahldieck acknowledges that digestion will take place at a faster rate if the operating temperature is elevated to the range 45 °C – 75 °C and thermophilic microorganisms are used (page 1, lines 21-27). However, Vahldieck recognizes a problem of maintaining a

sufficiently high level of oxygen in the sludge when the temperature of the sludge is elevated and which may be explained, in part, by the reduced solubility of oxygen (page 2, lines 26-31). To overcome the problem Vahldieck suggests, to maintain a sludge oxygen concentration of at least 2 mg/l ($2x10^{-3}$ kg/m^3) (page 4, lines 62), introducing a gas comprising at least 80% oxygen (by volume) to the sludge (page 8, lines 22-24). Although Vahldieck discloses the use of thermophilic microorganisms in the bio-oxidative digestion, it is submitted that the microorganisms responsible for the oxidative digestion are bacteria, as bacteria are known to constitute a majority of the microorganisms in activated sludge. It is further submitted that heterotrophic bacteria, which require organic compounds for their supply of carbon and energy, predominate. Evidence of the heterotrophic nature of the bacteria, in the sludge, is to be found in object of the Vahldieck reference i.e. to obtain sufficiently high levels of dissolved oxygen in the sludge to maintain its oxidative digestion at elevated temperatures, and in the fact that carbon dioxide, far from amounting to an additive as contemplated by the applicant (Fig. 1), is considered problematic to the method of Vahldieck (page 3, lines 3-9). The reasons why sufficiently high levels of dissolved oxygen are important, whilst elevated levels of carbon monoxide are problematic, to Vahldieck's teachings are that heterotrophic bacteria derive their energy from carbonaceous organic matter of the sludge and convert this organic matter, in the presence of oxygen, into carbon dioxide and water by-products. The current application does not rely on heterotrophic bacteria as **these bacteria are physiologically incapable of bio-leaching an inorganic substrate consisting of a sulphide mineral**. At the elevated temperatures contemplated in the present application i.e. temperatures in excess of 45 °C, reliance is placed on thermophilic chemolithotrophic microorganisms, such as *Sulfobacillus*, *Acidithiobacillus*, *Acidianus* and *Sulfolobus*, to bio-leach sulphide minerals. Chemolithotrophic micororganims

obtain their energy from the oxidation of inorganic (non-carbon) compounds. That is, they derive their energy from the energy already stored in chemical compounds which they use to build organic cellular compounds from an inorganic carbon source i.e. carbon dioxide, and hence the importance of supplementing a sulphide mineral slurry with carbon dioxide. While it is common to refer to the microorganisms used in bioleaching as being bacteria, strictly speaking, this is not the case since the chemolithotrophic thermophiles actually fall into another classification of microbiology, the *archaea* (Woes, CR and G E Fox, "Phylogenetic structure of the prokaryotic domain: The primary kingdoms," Proc. Natl. Acad. Sci. USA 74, 1977, pp 5088-5090). Hence *archaea* and bacteria, whilst similarly microscopic, actually belong to different kingdoms or domains of life. The problems encountered in an <u>organic</u> sludge bio-oxidation process and the solutions taught by Vahldieck cannot, without critical evaluation, be applied to an <u>inorganic</u> slurry bio-leaching process. This is especially so when considering that the heterotrophic bacteria of sludge bio-oxidation and the chemolithotrophic *archaea* of slurry bio-leaching require a distinctly different set of environmental factors within which to survive and thrive. The oxygen concentration in the liquid phase (C_L) is one such factor that differs in that whilst no upper limit for C_L is taught or suggested by Vahldieck as, it is submitted, this would be an unnecessary limitation as heterotrophic bacteria are not known to be inhibited by oxygen. Whereas, an upper limit for C_L is an essential integer in the Applicant's invention. The following extract from the present application explains why an upper limit for C_L is essential: "microorganism population growth is limited or prevented if the dissolved oxygen concentration reaches to a high level. A concentration level about 4×10^{-3} kg/m^3 has been found to be detrimental to *Sulfobacillus*-like strains. Certain *Acidithiobacillus* strains, however, have been found to be tolerant to dissolved concentrations up to 10×10^{-3} kg/m^3. Whilst the Applicant

may concede the Vahldieck reference is pertinent to the problem of ensuring adequate oxygen dissolution rates to a substrate at temperatures in excess of 45 °C, it submits that the examiner has erred in generally concluding that Vahldieck is "extremely pertinent to the problems associated with using thermophilic temperatures in biological oxidation reactors" for the above reasons. Applicant submits that one of ordinary skill in the art would not be motivated to combine Vahldieck with the other reference cited by the Examiner for the reasons stated herein. Therefore, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claims 51-65 stand rejected under 35 U.S.C 103(a) as being unpatentable over Emmet, Jr. (US 5,007,620) in view of Brierley (US 5,332,559), McWhirter (US 6,299,776), Eppstein (US 4,680,267), and Vahldieck (US 3,926,794) as applied to claims 50, 67-81 above, and further in view of Steemson (WO 94/28184). For the reasons provided above, Applicants assert that the prior art rejection is overcome and requests reconsideration and allowance of the claims.

In view of the foregoing, Applicant respectfully submits that the art rejections are overcome and that the application is now in condition for allowance. Accordingly, favorable reconsideration and allowance of the application is respectfully requested.

Respectfully submitted,

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